Gravity in Space

Recall: the space around a mass in which it exerts a gravitational influence is called its *field*. In this space it can exert a force on another mass because of its *gravitational field strength* '**g**', measured in N/kg. On Earth's surface, that field strength is 9.8 N/kg, but elsewhere the value for '**g**' is quite different.

To find the gravitational field strength '**g**' at *any* location, combine <u>both</u> versions of $\mathbf{F_g}$:

$$\mathbf{F_g = mg} \quad \text{and} \quad \mathbf{F_g = G\frac{Mm}{R^2}}$$

→equate these two to get $\mathbf{mg = G\frac{Mm}{R^2}}$

→cancel out small mass **m** and $\boxed{\mathbf{g = \frac{GM}{R^2}}}$

Here **M** is the mass of the Earth (or any *central* mass), and **R** is the distance you are from the ***center*** of that mass. Note that

R = radius of the Earth + altitude

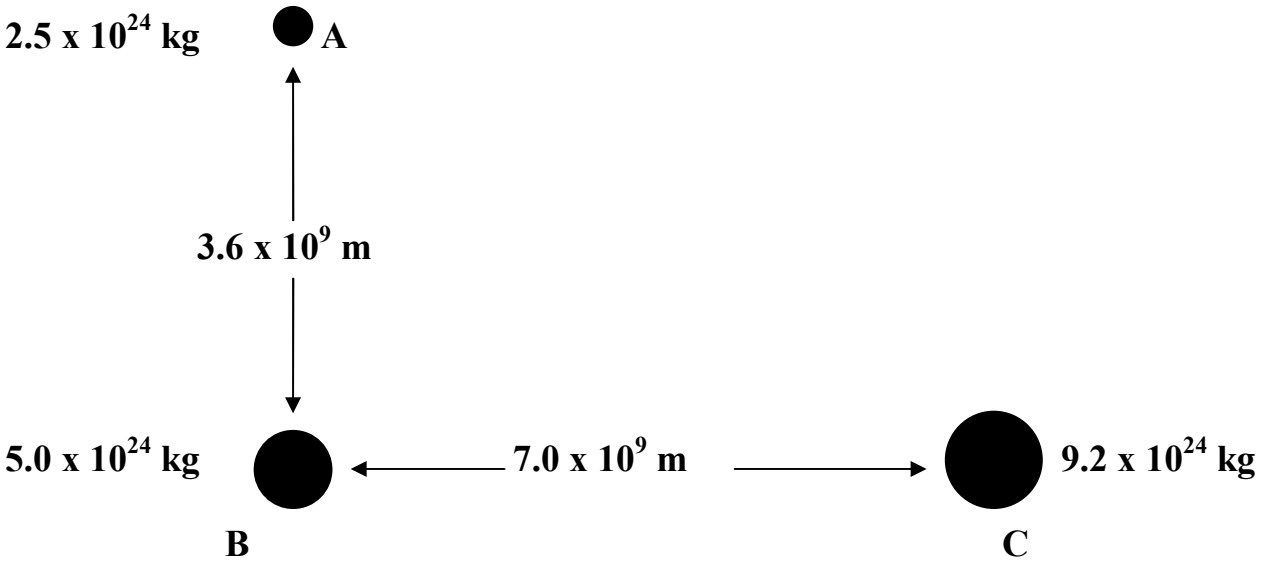
Example 3: Find 'g' at an altitude of 100 km.

(see Gravitation Ex 3 for answer)

All masses have a gravitational field strength surrounding them. This means the force of gravity can act on you anywhere in space, due to any number of objects that pull on you in different directions. For example, the Earth's oceans are spread throughout the planet due to its gravitational field strength pulling on the bodies of water. But the moon also exerts a pulling force of gravity on Earth's oceans, producing the daily high and low tides seen by any coastal region.

With different forces acting in different directions, we can find the *net force* on one mass due to the <u>combined</u> gravitational forces of two other masses in a specific position in space.

Example 4: Determine the net force acting on Planet B by the other two planets, as illustrated below:



To solve this type of problem, it may be helpful to follow this series of steps:
(1) Draw a free-body vector diagram showing the forces acting on Planet B.
(2) Calculate force $\mathbf{F_{AB}}$ using information on those two planets only.
(3) Calculate force $\mathbf{F_{BC}}$ in the same way as in (2).
(4) Determine the resultant force from the vector addition of $\mathbf{F_{AB}}$ and $\mathbf{F_{BC}}$.

(see Gravitation Ex 4 for answer)